Technical Data Sheet
UGI® 4435 IRH

Chemical analysis (%)

C	Si	Mn	Ni	Cr	Mo	N	P	S
≤ 0,03	≤ 1,0	≤ 2,0	12.5 – 14.0	17.0 – 19.0	2.5 – 3.0	≤ 0.11	≤ 0.045	≤ 0.030

27-04-2012 – REV00

General presentation

UGI® 4435 IRH is an austenitic stainless steel with a high Mo content and produced by a special method to optimize its cleanliness. Its composition provides it with very good corrosion resistance and is perfectly suited for prolonged contact with the skin. This grade also offers improved polishability, thanks to its inclusion population and its microstructure, adapted and controlled.

Classification

Austenitic stainless steel.

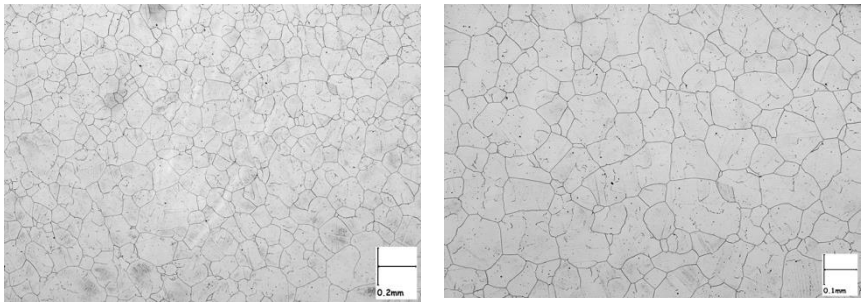
Designation

Europe EN	USA ASTM	Japan JIS
1.4435	316L	SUS316L

USA AISI	France AFNOR	Germany DIN	Switzerland Basler Norm BN2
316 L	X2CrNiMo18 14 3	1.4435	1.4435

Microstructure

The chemical composition of UGI® 4435 IRH is optimised to ensure primary ferritic solidification limiting hot workability problems and risks of crack formation at high temperature during welding, while providing it with a structure almost 100% austenitic at room temperature.



Transverse microstructure on ∅ 30 mm

Grain size as per ASTM E-112: ≥ 5 (≥ 4 if need of guarantee of residual ferrite < 0.5%).

Cleanliness as per DIN 50602, "M" method:

- Sulphides (SS) + Oxides in Alignment (OA) + Silicates (OS): ≤ 4
- Dispersed or globular oxides (OG): ≤ 1

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Mechanical properties
Tensile test data

State	Temperature T (°C)	Yield Stress YS (MPa)	Ultimate Tensile Strength UTS (MPa)	Elongation E (%)
Solution annealed	20	≥ 200	500-700	≥ 40
	100	≥165		
	200	≥137		
	300	≥118		
Ø ≤ 16 mm solution annealed + cold-worked by drawing	20	≥ 400	600-950	≥ 25
Ø ≥ 16 mm solution annealed + cold-worked by drawing	20	≥ 235	500-850	≥ 30

The drawing (cold working) operation helps enhance the metal's mechanical properties.

Impact strength data

Temperature T(°C)	Absorbed energy KV(J)
20	≥ 100

Hardness data

Temperature(°C)	Brinell(HB)	Vickers(HV)
20	144 - 202	160 - 205

Propriétés physiques

Tempera-ture (°C)	Density (kg/dm^3)	Modulus of elasticity (GPa)	Thermal conductivity (W.m^{-1}.K^{-1})	Coefficient of expansion (10^{-6}.K^{-1})	Electrical resistivity (µΩ.mm)	Specific heat (J.kg^{-1}.K^{-1})	Magnetism
20	8,0	200	15	-	0.75	500	no
100		194		16.0			
200		186		16.5			
300		179		17.0			
400		172		17.5			
500		165		18.0			

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Corrosion resistance

Uniform corrosion

Its higher molybdenum content provides it, in reducing mineral acids, with better uniform corrosion resistance than the conventional austenitics 1.4307 (304L) and 1.4404 (316L).

Localized corrosion

- Pitting corrosion and crevice corrosion

  It has very good corrosion resistance behaviour for a great majority of natural exposures (rural, urban and industrial). This grade, with high molybdenum content, offers among the best pitting and crevice corrosion resistance of the austenitic family.

  Its very good corrosion resistance behaviour means it easily complies with the EN1811 standard relating to nickel release.

- Intergranular corrosion

  Due to its low carbon content, this grade resists intergranular corrosion after welding and after sensitizing heat treatment as specified in the standards (ASTM A262-75 Practice E; DIN EN ISO 3651-2).

Hot working

Forging

The grade can be hot-worked at between 900°C and 1250°C and then cooled rapidly, in water or air.

Hot forming is generally followed by a solution annealing or quenching (see recommendations in the corresponding section).

Cold working

Wire drawing – Shaping

The 4435 IRH grade has good cold forming capability. Its high cold work hardening compared with non-austenitic grades induces the use of appropriate tools. Cold working can make the grade very slightly magnetisable through the formation of strain-induced martensite.

Bending – Forming

Good bending and forming capability.

Machinability

Thanks to control of its inclusion population and microstructure, UGI® 4435 IRH can retain a satisfactory machinability level while ensuring optimal polishability for the grade.

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Welding

UGI® 4435 IRH can be resistance welded (spot or seam welding) by any type of arc process (MIG, TIG, submerged arc, covered electrode), by laser, electron beam, etc.

UGI® 4435 IRH is balanced to be on the boundary of primary ferritic solidification in order to ensure a minimum of residual ferrite in the welding region while limiting its risk of crack formation at high temperature during arc welding. In laser welding, the risk of crack formation at high temperature is greater than with arc welding, and the welding parameters should be adjusted as well as possible on a case by case basis to limit this risk.

Where a filler wire is used to weld UGI® 4435 IRH to itself, preferably choose an ER316L(Si) – 1.4430 wire.

The protection gases in arc welding should preferably be:
- In MIG: Ar (+ possibly He) + 2% to 3% O_2 or CO_2
- In TIG: Ar (+ possibly He)

No preheating or post-welding heat treatment is required. Interpass temperatures not exceeding 150°C should be complied with.

Heat treatment

Solution treatment (solution annealing)

The solution annealing treatment can ensure optimal corrosion resistance properties. It should be performed at a temperature ranging between 1050°C and 1120°C and followed by rapid cooling in water or air (for products of small cross section).

Surface treatment

Type	Medium	Comments
Pickling	6 – 25% HNO_3 + 0.5 – 8% HF	In the annealed state only and at high temperature
Passivation	20 – 50% HNO_3	At high temperature

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Available products

Product	Shape	Finish	Tolerance	Dimensions	
Bar	Round	Rolled & descaled	k13	Ø 13 to 130	mm
		Turned	10 + 11	Ø 22 to 130	mm
		Ground	7 + 8 + 9 + options	Ø 2 to 130	mm
		Drawn	9	Ø 2 to 30	mm
		Black bar	+/- 1% of ø	Ø 23 to 135	mm
	Hexagonal	Drawn	10 + 11	Hex. 3 to 55	mm
Wire Rod	Round	Rolled		Ø 5 to 32	mm
		Rolled & pickled		Ø 5 to 32	mm
	Hexagonal	Rolled & pickled		Hex. 12.4 to 28	mm
Billet	Square	As-rolled or as-heat-treated		50 to 120	mm

Other possible options. Please consult us.

Applications

- Watchmaking
- Pharmaceuticals